REMARKS

The Office Action dated August 25, 2003 has been received and carefully noted. The following remarks are submitted as a full and complete response thereto. No new matter has been added. Accordingly, claims 1-3, 5-7 and 9-11 are pending in this application and are submitted for consideration.

Applicants acknowledge and thank the Examiner for indicating that claim 6 is allowable over the prior art and that claims 5 and 10 would be allowable over the prior art if amended to be in independent form. However, Applicants respectfully submit that all of the presently pending claims recite allowable subject matter and therefore, placing claims 5 and 10 into independent form is not necessary.

Claims 1-3, 7 and 9 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Iino et al. (U.S. Patent No. 6,407,329, "Iino") in view of Yamagishi et al. (U.S. Patent No. 6,300,556 "Yamagishi"), with evidence provided by Komada et al. ("Novel Transparent Gas Barrier Film Prepared by PECVD Method", 43rd Annual Technical Conference Proceedings of the Society of Vacuum Coaters, (April 15-20, 2000) pp. 353-356, "Komada").

However, according to MPEP § 201.15, a priority claim can be perfected where the Applicants file a certified verified copy and translation of the foreign priority document. Although there are three priority documents, the earliest foreign priority date of the present invention is January 31, 2000 (Japanese Patent Application 2000-22092 and Japanese Patent Application 2000-22094), which is prior to the November 16, 2000 filing date of Iino and the April 15, 2000 publication date of Komada. Support for claims 1-3, 7 and 9 can be found generally in Japanese Patent Application 2000-22092 in Figs.

1-8, and paragraphs [0028] to [0043] of the specification. Additionally, support for claims 1-3, 7 and 9 can be found generally in Japanese Patent Application 2000-22094 in Figs. 1-6, claims 1-8, and paragraphs [0015] to [0025] of the specification. Therefore, Applicants hereby submit herewith verified English translations of the foreign priority documents, Japanese Patent Application 2000-022092, and Japanese Patent Application 2000-022094, under 37 C.F.R. § 1.55(a). Certified copies of the priority documents were filed with the application, and was acknowledged in the Office Action dated July 16, 2002.

The Examiner is respectfully requested to review the documents and to withdraw the rejection with respect to claims 1-3, 7 and 9 in view of the entitlement of the present application to its priority date as a date of invention.

In view of the above remarks, because Iino is not a valid prior art reference under 35 U.S.C. § 102(a) or 35 U.S.C. § 103(a), Applicants respectfully submit that each of claims 1-3, 7 and 9 recite subject matter which is neither disclosed nor suggested in the cited prior art. Applicants submit that this subject matter is more than sufficient to render the claimed invention unobvious to a person of ordinary skill in the art.

Claim 11 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Yamagishi in view of Otani et al. (PG-Pub 2001/0009160 A1, "Otani"). In making this rejection, the Office Action took the position that Yamagishi discloses all the elements of the claimed invention except for disclosing that the rear surface resin film has a WVTR not higher than 6.3 g/m^2 day. Otani is cited for disclosing this limitation.

However, U.S. filing date of the present invention is January 31, 2001, which is prior to the March 8, 2001 filing date of Otani. Therefore, Applicants submit that Otani is

not a valid prior art reference and respectfully request that the rejection be withdrawn.

In view of the above remarks, because Otani is not a valid prior art reference Applicants respectfully submit that claim 11 recites subject matter which is neither disclosed nor suggested in the cited prior art. Applicants submit that this subject matter is more than sufficient to render the claimed invention unobvious to a person of ordinary skill in the art.

In view of the foregoing, reconsideration of the application, withdrawal of the outstanding rejections, allowance of claims 1-3, 7 and 9-11 (claim 6 already being allowed and claims 5 and 10 being indicated as reciting allowable subject matter), and the prompt issuance of a Notice of Allowability are respectfully solicited.

If this application is not in condition for allowance, the Examiner is requested to contact the undersigned at the telephone listed below.

In the event this paper is not considered to be timely filed, the Applicants respectfully petition for an appropriate extension of time. Any fees for such an extension, together with any additional fees that may be due with respect to this paper,

may be charged to counsel's Deposit Account No. 01-2300, **referencing docket number <u>107336-00016</u>.**

Respectfully submitted,
ARENT FOX KINTNER PLOTKIN & KAHN PLLC

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Enclosures: Verified Translation of Japanese Patent Application 2000-022092
Verified Translation of Japanese Patent Application 2000-022094

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LDA/grs

I, Hiroshi Torii of 14-5 Tomatsu-cho 1chome, Amagasaki-shi, Hyogo, 661-0003, Japan, do hereby declare that I am the translator of the priority document No.2000-22094 for U.S. Patent Application No. 09/772,994 and certify that the following is a true translation to the best of my knowledge and belief.

Signed this November 18, 2003

Hiroshi Torii

Hiroshi Torii

PATENT OFFICE
JAPANESE GOVERNMENT

This is to certify that the annexed is a true copy of the following application as filed this Office.

Date of Application : January 31, 2000
Application Number : 2000-022094
Applicant(s) : Sanyo Electric Co., Ltd.

Date : December 1, 2000

Commissioner, Kozo Oikawa (Sealed)
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[Document]	Abstract	1

[Assigned Number of Applicant to the Attorneys] 9005894

[Proof] necessary

[Document Name] Specification

[Title of the invention] Solar Cell Module

[Scope of Claim for Patent]

[Claim 1] A solar cell module comprising a plurality of solar cell elements sealed with sealing resin between a front surface glass and a rear surface member, wherein the sealing resin between the front surface glass and the rear surface member has a thickness of 1.0 mm or more.

[Claim 2] A solar cell module comprising a plurality of solar cell elements sealed with sealing resin between a front surface glass and a rear surface member, wherein a resin layer having a lower water vapor transmission rate than that of the sealing resin is interposed between the front surface glass and the rear surface member.

[Claim 3] A solar cell module according to claim 2, wherein the resin layer having a lower water vapor transmission rate than that of the sealing resin is a PET film.

[Claim 4] A solar cell module comprising a plurality of solar cell elements sealed with sealing resin between a front surface glass and a rear surface member, wherein a PET film is interposed between the front surface glass and the rear surface member.

[Claim 5] A solar cell module according to claims 1 to 4, wherein the rear surface member is formed of a light transmitting material.

[Claim 6] A solar cell module comprising a plurality of solar cell elements sealed with sealing resin between a front surface glass and a light transmitting rear surface member, wherein the light transmitting rear surface member has a water vapor transmission rate of $6.3 g/m^2 \cdot$

day or less.

[Claim 7] A solar cell module according to claim 6, wherein the light transmitting rear surface member is an inorganic oxide layer, a nitride layer, or a fluoride layer formed on a heat resistant film.

[Claim 8] A solar cell module according to claim 6, wherein the light transmitting rear surface member is formed by laminating a thin plate glass and a resin film.

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

This invention relates to a solar cell module, particularly is suitably used for a two-side incidence type solar cell module capable of entering light from both front and rear surfaces provided with transparent front and rear surface members.

[0002]

[Prior Art]

Because solar light is unexhausted energy, a solar cell device for directly converting light energy into electrical energy has been developed as energy source to substitute for environmentally harmful fossil fuel such as petroleum and coal. A plurality of solar cell elements are electrically connected in series or in parallel with each other to form a solar cell module and increase their output. The solar cell module can be used as a practical energy source.

[0003]

A conventional solar cell module that generates power on a one-side surface, as shown in Fig. 7, is so structured that a plurality of solar cell elements 110 between a front surface glass 100 and a rear surface member 101 are sealed with a transparent and insulative resin 102 such as EVA (ethylene vinyl acetate).

[0004]

The solar cell element 110 contains a single crystalline silicon, polycrystalline silicon or the like, and the solar cell elements 110 are connected in series with connection members 111 of a metal thin plate such as a copper foil plate or the like. The rear surface member 101 is a lamination film with a metal foil such as an aluminum (Al) foil or the like sandwiched with plastic films so that water entrance from a rear surface can be prevented.

[0005]

The above-mentioned solar cell module is integrally formed by sandwiching the solar cell elements 110 between the front surface glass 100 and the rear surface member 101 with a resin sheet of EVA or the like of 0.4-0.8 mm in thickness interposed, and heating it at a reduced pressure.

[0006]

[Problems to be resolved by the Invention]

The solar cell modules should be weather proof in order to withstand long-term use outside. The above-mentioned structure, which uses the lamination film with a metal foil sandwiched with plastic films for the rear surface member 101, can suppress water entrance from the outside.

Therefore the solar cell module can maintain high power generation performance over the long term, but it still requires to be improved.

[0007]

On the other hand, a two-side incidence type solar cell element has been proposed, which is so structured that an electrode on a rear surface, not only an electrode on a light incidence side, is a transparent electrode in order to take light into the solar cell elements effectively. In such structure, the rear surface of this solar cell element is formed of transparent material. The rear surface member made of the transparent material allows water to enter easier than the rear surface member of the lamination film with a metal foil sandwiched with plastic films does. Further measure to prevent water seeping should be taken. Although the use of a transparent resin film having a low water vapor transmission rate has been proposed, it still requires to be improved.

[0008]

This invention was made to solve above-mentioned conventional problems and to provide a solar cell module with reliability enhanced by improving moisture proofness.

[0009]

[Means of Solving the Problems]

First of all, a solar cell module shown in Fig. 7 including a lamination film of an aluminum (Al) foil sandwiched with PVF (polyvinyl fluoride) films and a solar cell module only including a PVF film were prepared, and a moisture proof test (JIS C8917) on the two modules were conducted to examine causes of degradation of power generation

performance by water entrance. In this test, the modules were put in a thermostatic bath of 85℃, 93% RH for approximately 1000 hours and the solar cell characteristics before and after the test were examined. An acceptable value of output is 95% or higher. In this test, the modules were put in the thermostatic bath for 1000 hours. The rate of change in output is 99.0 % when the rear surface member is a lamination film, and the rate is 92.0 % when the PVF film is used. According to a careful consideration of the two solar sell modules, a quantity of sodium in 1g of the resin for sealing the solar cells of the solar cell module using the lamination film is 0.3 μ g/g, and that of the solar cell module using only the PVF film is 3 μ g/g. The quantity of sodium relates to the rate of change in output, and as the quantity of sodium in the resin increases, the power generation performance degrades.

[0010]

It is considered that the quantity of sodium changes under the influence of water entrance. Regarding the solar cell module using the lamination film as a rear surface member, water enters from the outer region of the module. The solar cell module using the resin film as the rear surface member, in addition to the water entrance from the outer region of the module, receives water through the resin. Thus more water enters the solar cell module using the resin film for the rear surface member.

[0011]

When the water enters the module, the sodium ions deposited from the front glass migrate in the resin containing water to reach the front surface of the solar cell element, and further diffuse inside the solar cell

element to degrade the power generation performance of the solar cell. As a result, the power generation performance seems to degrade when the rear surface member is the resin film as compared with the lamination film.

[0012]

This invention was made to improve reliability of the solar cell module by suppressing the sodium ions deposited from the front surface glass from diffusing to the front surface of the solar cell elements.

[0013]

A solar cell module of the present invention was made in consideration of the above-mentioned problems and comprises a plurality of solar cell elements sealed with sealing resin between a front surface glass and a rear surface member. The sealing resin between the front surface glass and the rear surface member has a thickness of 1.0 mm or more.

[0014]

With the above structure, a distance between the front surface glass and the solar cell elements can be extended more than usual. The extended distance can delay the sodium ions deposited from the front surface glass reaching the solar cell elements. Thus it takes time to degrade the power generation performance of the solar cell elements; therefore, the present invention provides a high-reliable solar cell module, which is suitable for long-term and outdoor use.

[0015]

A solar cell module of the present invention comprises a plurality of solar cell elements sealed with sealing resin between the front surface glass

and the rear surface member. A resin layer having a lower water vapor transmission rate than that of the sealing resin is interposed between the front surface glass and the rear surface member.

[0016]

With the above structure, the resin layer having a low water vapor transmission rate can block the sodium ions deposited from the front surface glass, thereby preventing the degradation of power generation performance of the solar cell elements.

[0017]

Additionally, the resin layer having a lower water vapor transmission rate than that of the sealing resin may be a PET film.

[0018]

A solar cell module of the present invention comprises a plurality of solar cell elements sealed with sealing resin between a front surface glass and a rear surface member. A PET film is interposed between the front surface glass and the rear surface member.

[0019]

With the above structure, the PET can block the sodium ions deposited from the front surface glass, thereby preventing the degradation of power generation performance of the solar cell elements.

[0020]

The rear surface member may be made of transparent materials.

[0021]

An EVA resin may be used for the sealing resin.

[0022]

A solar cell module of the present invention comprises a plurality of solar cell elements sealed with sealing resin between a front surface glass and a light transmitting rear surface member. The light transmitting rear surface member has a water vapor transmission rate of $6.3 g/m^2 \cdot day$ or less.

[0023]

The light transmitting rear surface member may be an inorganic oxide layer, a nitride layer, or a fluoride layer formed on a surface of the rear surface resin film.

[0024]

The light transmitting rear surface member may be a lamination film of a thin plate glass and a resin film.

[0025]

With the above structure, water vapor can be prevented from entering through the rear surface, thereby reducing the deposition of sodium ions from the front surface glass.

[0026]

[Preferred Embodiment of the Invention]

Explanation is made on the embodiments by referring to the drawings.

[0027]

One example of a solar cell element 1 used in this invention is explained by referring to Fig. 1. Fig. 1 is a schematic perspective view illustrating one example of a solar cell element capable of entering light from both front and rear surfaces. This solar cell element is so structured that intrinsic amorphous silicon is sandwiched between a single crystalline

silicon substrate and an amorphous silicon layer (herein after referred as HIT structure) in order to reduce defects on the interface therebetween and improve hetero junction interface characteristics, and is capable of entering light from both front and rear surfaces.

[0028]

As shown in Fig. 1, an intrinsic amorphous silicon layer 11 is fomed on an n-type single crystalline silicon substrate 10, and a p-type amorphous silicon layer 12 is formed thereon. A transparent electrode 13 on a light receiving side is formed of ITO on an entire surface of the p-type amorphous silicon layer 12, and a comb-shaped collector 14 of silver (Ag) or the like is formed on the transparent electrode 13 on a light receiving side. A rear surface of the substrate 10 has a BSF (Back Surface Field) structure which introduces an internal electric field on the rear surface of the substrate; a high dope n-type amorphous silicon layer 16 is formed with an intrinsic amorphous silicon layer 15 interposed on a rear surface side of the substrate 10. A transparent electrode 17 on a rear surface side is formed of ITO on an entire surface of the high dope n-type amorphous silicon layer 16, and a comb-shaped collector 18 of silver (Ag) or the like is formed thereon. The rear surface also has a BSF structure which the intrinsic amorphous silicon layer is sandwiched between the crystalline silicon substrate and a high dope amorphous silicon layer in order to reduce defects on the interface and improve characteristics of the hetero junction interface.

[0029]

A plurality of the solar cell elements 1 of Fig. 1 are connected in series with connection member (not shown), and a solar cell module is formed by sealing the plurality of solar cell elements 1 with EVA (ethylene vinyl acetate) resin between a front surface glass 20 and a rear surface resin film 5.

[0030]

In this embodiment, a lamination film of an aluminum foil (Al) sandwiched between PVF (polyvinyl fluoride) films is used as the rear surface resin film 5 to prevent water entrance.

[0031]

In the first embodiment illustrated in Figs. 2, 3, an EVA resin sheet 3 of 0.6 mm in thickness and an EVA resin sheet 4 of 0.4 mm are laid to be 1.0 mm in thickness altogether between the front surface glass 20 and the solar cell elements 1. In addition an EVA resin sheet 2 of 0.6 mm in thickness is interposed between the solar cell elements 1 and the rear surface member 5. The EVA resin sheets adjacent to the front surface glass 20 may be replaced with a single EVA sheet of 1.0 mm in thickness.

[0032]

The above-mentioned solar cell module is integrally formed by sandwiching the solar cell elements 1 between the front surface glass 20 and the rear surface member 5 with the EVA resin sheets 3, 4 having total thickness of 1.0 mm and the EVA resin sheet 2 of 0.6 mm in thickness interposed and heating it at a reduced pressure. As shown in Fig. 3 a plurality of solar cell elements 1 are sealed with the EVA resins 2, 3, 4 between the front surface glass 20 and the rear surface member 5.

[0033]

In the solar cell module shown in Fig. 3, the distance between the front surface glass 2 and the solar cell elements 1 should be extended more than usual; for example approximately twice compared with the solar cell module using the single EVA sheet of 0.6 mm in thickness. As a result, the extended distance delays sodium ions deposited from the front surface glass 20 reaching the solar cell elements 1. Thus it takes time to degrade the power generation performance of the solar cell elements; therefore, the present invention provides a high-reliable solar cell module that is suitable for long-term and outdoor use.

[0034]

Figs. 4, 5 explain the second embodiment of this invention. The same elements have the same reference numerals as in the first embodiment, and explanation on them is omitted.

[0035]

As shown in Fig. 4, 5, a plastic film 6 having a lower water vapor transmission rate than that of EVA resins is inserted between the EVA sheets 3 and 4 which are laid between the front surface glass 20 and the solar cell elements1. An inexpensive PET film may be recommendable to use as the plastic film 6. In consideration of workability, the thickness of the PET film may be 25 μm or more. If both of price and workability is taken into consideration, the thickness of the EVA resin should be 0.2 – 0.6 mm.

[0036]

In the embodiment shown in Fig. 4, two EVA resin sheets 3 and 4

respectively having thickness of 0.4 mm are laid between the front surface glass 20 and the solar cell elements 1, and a PET film 6 is interposed between the EVA resin sheets 3 and 4. Additionally, an EVA sheet 2 of 0.6 mm in thickness is used between the solar cell elements 1 and the rear surface member.

[0037]

The EVA sheet 4, PET film 6 and EVA sheet 3 interposed in this order between the front surface glass 20 and the solar cell elements 1 and the EVA sheet 2 sandwiched between the solar cell elements 1 and the rear surface member 5 are integrated by the application of heat at a reduced pressure to form the above-mentioned solar cell module. In that way, as shown in Fig. 5, the solar cell module is formed with a plurality of solar cell elements 1 sealed with the EVA resins between the front surface glass 20 and the rear surface member 5.

[0038]

In the solar cell module, the PET film 6 can block the sodium ions deposited from the front surface glass 20, thereby preventing the degradation of power generation performance of the solar cell elements 1.

[0039]

The solar cell module of this invention and a conventional solar cell module were subjected to a moisture proof test. The result is indicated as follows. In this test, the solar cell modules were put in a thermostatic bath of 85℃, humidity of 93% for approximately 1000 hours and characteristics of the solar cells are examined before and after the test. An output value of 95% or higher is an acceptable line. Also the moisture

proof test was carried out on the same conditions of temperature 85℃ and humidity 93% but for 2000 hours. The result is indicated in table 2.

[0040]

The sample uses a lamination film of an aluminum foil (Al) sandwiched between PVF (polyvinyl fluoride) films as the rear surface member 5 in order to prevent water from entering from the rear surface, and an EVA resin 2 on the rear surface side of 0.6 mm in thickness. The conventional example is formed in the same way except for the EVA resin sheet on the front side has thickness of 0.6 mm.

[0041]

The first embodiment is a solar cell module that has the structure illustrated in Fig. 3 and uses EVA sheets 3 and 4 respectively having thickness of 0.6 mm and 0.4 mm, which become an EVA sheet of 1.0 mm in total, on the front surface side. The second embodiment is a solar cell module that has the structure illustrated in Fig. 5 and uses a PET film 6 of 50 μm in thickness interposed between two EVA resin sheets 3 and 4 having thickness of 0.4 mm. Each sample is a single-side power generation module which light is incident from only a side of the front surface glass 20. Degradation from the initial characteristics of the samples is watched. The measurements of an amount of sodium (Na) in 1g of the sealing resin after a lapse of 1000 hours and 2000 hours are also shown.

[0042]

[Table 1]

	Rate of change in output characteristic [%]				
	Pmax	Voc	Isc	F.F.	Na quantity /EVA
(Conventional example) front EVA resin of 0.6 mm	99.0	99.8	99.9	99.3	0.3 μg/g
(First embodiment) front EVA resin of 1.0 mm	99.2	99.7	99.3	99.6	0.2 μg/g
(Second embodiment) PET film (50 μm)between front EVA resins of 0.4 mm	99.5	99.9	99.4	99.7	0.1 μg/g

[0043]

[Table 2]

	Rate of change in output characteristic [%]				
	Pmax	Voc	Isc	F.F.	Na quantity /EVA
(Conventional example) front EVA resin of 0.6 mm	93.9	98.5	99.5	95.8	2.0 μg/g
(First embodiment) front EVA resin of 1.0 mm	96.1	99.2	99.6	97.3	0.9 μg/g
(Second embodiment) PET film (50 μm)between front EVA resins of 0.4 mm	98.0	99.5	99.7	98.8	0.5 μg/g

[0044]

From the table 1, it is found that the performance of the solar cell module of this invention after a lapse of 1000 hours is less degraded than that of the conventional example. Either of them can satisfy 95% or higher level of the initial properties, and can achieve the JIS standard.

[0045]

As apparent from the table 2, however, the value of Pmax of the conventional example falls below 95%, which means degradation of performance. On the other hand, either solar cell module of the present invention including the EVA resin of 1.0 mm on the front surface side and the solar cell module including the PET film 6 interposed between two EVA resin sheets satisfy 95% or higher level. It is found that the solar cell

modules of the present invention improve their moisture proofness far greater than the conventional example.

[0046]

Explanation is made on the water vapor transmission rate of each of the material. The water vapor transmission rate is measured by Mocon method (JIS Z 0208-73).

[0047]

The water vapor transmission rate of the EVA sheet of 0.6 mm is 63 $g/m^2 \cdot day$, the PET film of 50 μm is 12.6 $g/m^2 \cdot day$.

[0048]

The water vapor transmission rate is inversely proportional to a thickness; for example when the thickness is doubled, the water vapor transmission rate is halved. Therefore, when the thickness of the EVA sheet is 1.0 mm, the water vapor transmission rate is 37.8 $g/m^2 \cdot day$.

[0049]

The sodium ions deposited from the front surface glass 20 can be prevented from reaching the solar cell elements 1 by increasing a thickness of the resin layer between the front surface glass 20 and the solar cell elements 1 or interposing the resin layer having a lower water vapor transmission rate than that of the sealing resin between the front surface glass 20 and the solar cell elements 1, thereby preventing degradation of power generation performance of the solar cell elements.

[0050]

Descriptions were made on the embodiments in which solar cell module that receive light on one surface uses the present invention.

[0051]

Next description is about a two-side incidence type solar cell module using the present invention. Although the above-mentioned embodiment uses a film of an aluminum sandwiched between PVF films as the rear surface member, the two-side incident type solar cell module uses a transmission type plastic film. Samples using PET film and PVF film as the transmission type plastic film were prepared and the moisture proof test was conducted. The samples were put in a thermostatic bath of 85 ℃, 93% RH for approximately 1000 hours and the characteristics of the solar cells before and after the test were examined. The output value of 95% or higher is an acceptable standard. The results are shown in the table 3. Sample No. 1 is a conventional example and uses a lamination film of an aluminum foil sandwiched between the PVF films as the rear surface material 5 in order to prevent water entrance from the rear surface. The thickness of the EVA sheet 2 on the rear surface side is 0.6 mm and the thickness of the EVA sheet on the front surface side is 0.6 mm.

[0052]

Sample No.2 is one that has the same structure as the above conventional samples except that the rear surface member 5 is a PVF film of 50 μm in thickness and the EVA sheet on the front surface side is 0.6 mm in thickness. Sample No.3 is one that has the same structure as the above conventional samples except that the rear surface member 5 is a PET film of 50 μm in thickness and the EVA sheet on the front surface side is 0.6 mm in thickness. The sample No.4 is one that has the same

structure as the above conventional samples except that the rear surface member 5 is a PET film of 100 μm in thickness and the EVA sheet on the front surface side is 0.6 mm in thickness. Sample No.5 is one that has the structure as shown in Fig. 3 using a PET film of 100 μm in thickness as the rear surface member 5 and the EVA sheet of 1.0mm on the front surface side which is formed of two EVA sheets 3 and 4 respectively of 0.6mm and 0.4mm in thickness. Sample No. 6 is one that has the structure as shown in Fig. 5 and uses a PET film of 50 μm in thickness as the rear surface member 5 and a PET film 6 of 50 μm in thickness interposed between the EVA resin sheets 3 and 4 of 0.4 mm respectively. Among these samples, the sample No. 1 is a one-side incident type power generation module, which receives light from the front surface glass 20, and the other samples are two-sides incident type power generation modules, which receive light from the front and rear surfaces. Degradation from the initial characteristics of the samples is watched. The measurement of an amount of sodium (Na) in 1g of the sealing resin is also shown.

[0053]

[Table 3]

		Rate of change in output characteristic [%]				
		Pmax	Voc	Isc	F.F.	Na quantity /EVA
1	Conventional structure (front EVA sheet of 0.6mm)	99.0	99.8	99.9	99.3	0.3μg/g
2	Rear surface resin film of PVF film (50μm), front EVA sheet of 0.6mm	92.0	98.2	99.3	94.3	3.0μg/g
3	Rear surface resin film of PET film (100μm), front EVA sheet of 0.6mm	93.5	98.5	99.4	95.5	2.3μg/g
4	Rear surface resin film of PET film (100μm), front EVA sheet of 0.6mm···comparison with No.3 sample	95.5	99.1	99.5	96.9	1.2μg/g
5	Rear surface resin film of PET film (50μm), front EVA sheet of 1.0mm···comparison with No.3 sample	95.8	99.2	99.5	97.1	1.0μg/g
6	Rear surface film of PVF (50μm), PET film (50μm) interposed between front EVA resins (each 0.4mm)	99.0	99.8	99.9	99.3	0.1μg/g

[0054]

It is found from the table 3 that Sample No. 4 using the PET film of 100 μm as the rear surface member 5 could maintain 95% or higher level of the initial characteristics, but Samples No. 2 and 3 could not maintain 95% or higher level of the initial characteristics. When the thickness of the EVA sheet on the front surface side increases, the sample as in the case of the No. 5 could maintain 95% level of the initial characteristics in comparison with Sample No. 3. Furthermore, one that has the structure as shown in Fig. 5 (Sample No. 6) could achieve the same level as that of the conventional example using the lamination film of the Al foil sandwiched between PVF films as the rear surface member 5.

[0055]

The water vapor transmission rate of the PET film of 100 μm is 6.3 g/m^2·day, and the PVF film of 50 μm is 15 g/ m^2·day.

[0056]

It can be said from the table 3 that the two-side incidence type structure requires to prevent water transmission from the rear surface side as possible. Therefore materials having a low water vapor transmission rate preferably should be used for the rear surface member 5.

[0057]

By making the water vapor transmission rate of the rear surface member be 6.3 g/m^2 or less, 95% or higher level of the initial characteristics can be maintained even after the lapse of 1000 hours. Fig. 6 explains an embodiment using the materials of the low water vapor transmission rate for the rear surface member 7. In Fig. 6, the same elements have the same reference numerals as in Fig. 5.

[0058]

The plastic film shown in Fig. 6 is, for example, a PET film 7a with SiOx 7a or the like with a water barrier property deposited. In the structure, the sodium ions deposited from the front surface glass 20 is hard to move with decrease in amount of water entering from the rear surface member 7. As a result, the structure prevents power generation performance of the solar cell from degrading.

[0059]

Additionally, the light transmitting rear surface member having a low water vapor transmission rate is formed by providing a thin plate glass 7b of 0.005 to 0.1 mm in thickness between a rear surface member 7a

such as a PVF film and PET film and an EVA sheet 2 to function as the rear surface member 7.

[0060]

Although a PET film 6 is provided between the EVA sheets 3 and 4 adjacent to the front surface glass 20 in the embodiment shown in Fig. 6, the embodiment can obtain moisture resistance good enough to satisfy the JIS without the PET film 6. However it is better to provide the PET film 6 for better moisture resistance.

[0061]

As mentioned above, the two-sides light incident type solar cell module can improve its moisture resistance by using a film having a very low water vapor transmission rate as the rear surface member as well as using a thick EVA film on the front surface side or interposing a PET film between the EVA films.

[0062]

EVA used for the sealing resin in the above-mentioned embodiments may be replaced with silicone, polyvinyl chloride, PVB (polyvinyl butyral), or polyurethane.

[0063]

Heat resistance films of PVF (polyvinyl fluoride), PVDF (polyvinylidene fluoride), FEP (tetrafluoroethylene-hexafluoropropylene), ETFE (ethylene-tetrafluoroethylene), PC (poly carbonate), PVC (polyvinyl chloride), and PMMA (polymethyl methacrylate) can be used as the rear surface resin film 5 instead of the PET film. Also the rear surface resin film 5 can be formed by depositing inorganic oxide (aluminum oxide,

silicon oxide), nitride (SiN), fluoride (HgF, CaF) or the like on the heat resistance film such as PET. Because of water barrier property provided with the inorganic oxide, the film with the inorganic oxide can suppress the water vapor transmission rate more than the film alone does.

The above embodiments uses the solar cell element of the HIT structure, but other types of solar cell module using crystalline solar cell elements formed of single crystalline silicon or polycrystalline silicon, and amorphous solar cell elements are applicable.

[0064]

[Effects of the Invention]

As described above, this invention can provide a solar cell module of high reliability capable of suppressing deposition of sodium ion from the front surface glass, extending time of degrading power generation performance of the solar cell element, and withstanding long-term use in the outside.

[Brief Explanation of the Drawings]

[Fig. 1]

Fig. 1 is a schematic perspective view illustrating one example of a solar cell element capable of entering light from both front and rear surfaces;

[Fig. 2]

Fig. 2 is an exploded side view of the solar cell module according to the first embodiment of this invention;

[Fig. 3]

Fig. 3 is a side view of the solar cell module according to the first embodiment of this invention;

[Fig. 4]

Fig. 4 is an elploded side view of the solar cell module according to the second embodiment of this invention;

[Fig. 5]

Fig. 5 is a side view of the solar cell module according to the second embodiment of this invention;

[Fig. 6]

Fig. 6 is a side view of the solar cell module according to the third embodiment of this invention;

[Fig. 7]

Fig. 7 is a side view of the solar cell module according to the conventional solar cell module.

[Explanation of reference number]

1	Solar cell element
2, 3, 4	EVA sheet
5	rear surface member
6	PET sheet

【Document Name】 Drawings

Fig. 1

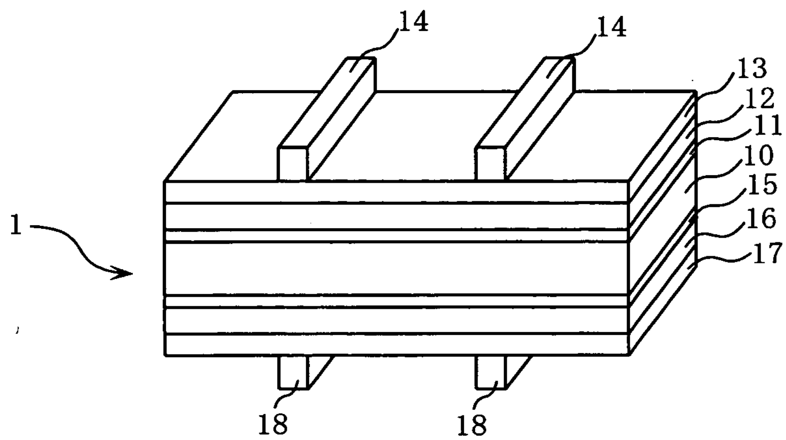


Fig. 2

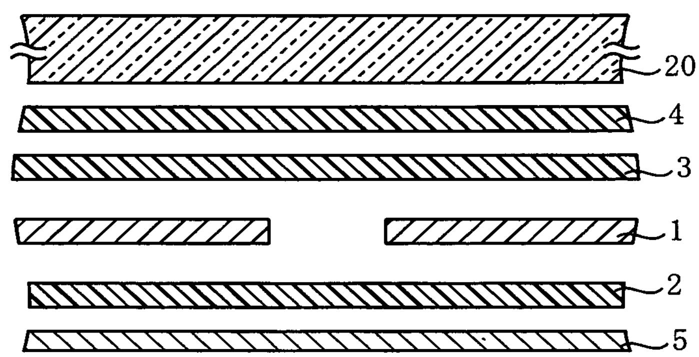


Fig. 3

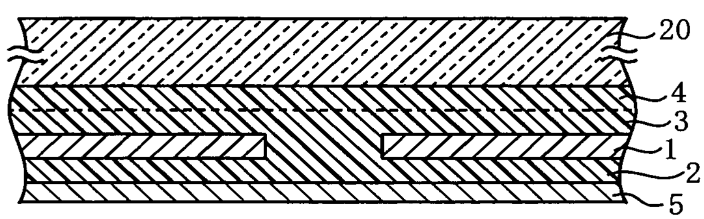


Fig. 4

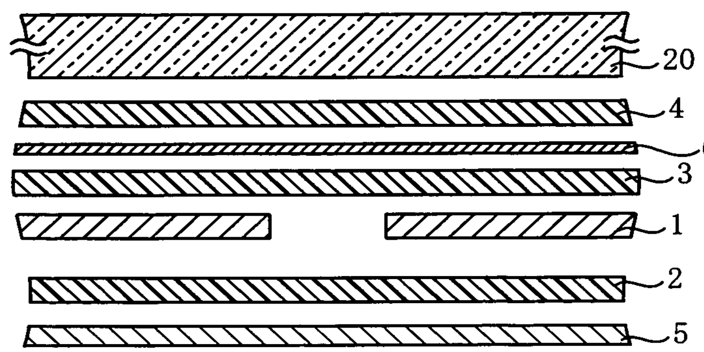


Fig. 5

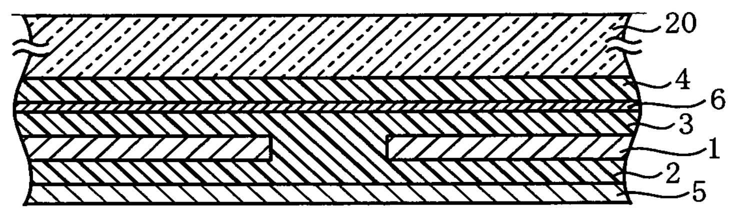


Fig. 6

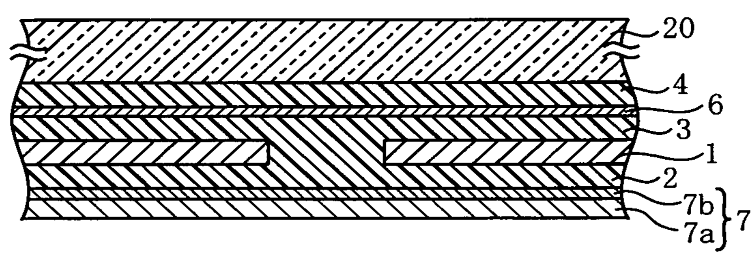
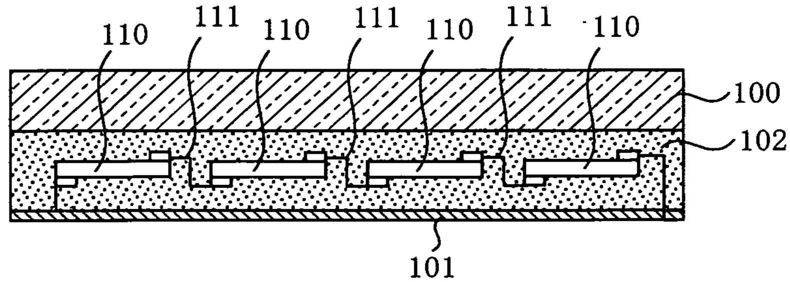


Fig. 7



[Document name] Abstract

[Abstract]

[Object] The present invention has an object to provide a solar cell module with moisture proofness improved by suppressing sodium ions deposited from a front surface glass to reach solar cell elements.

[Means to solve]A solar cell module comprises a plurality of solar cell elements 1 sealed with an EVA resin between a front surface glass 20 and a rear surface member 5. A PET film having a lower water vapor transmission rate than that of EVA sheets 3 and 4 is interposed between the front surface glass 20 and the solar cell elements.

[Selected drawing] Fig.5

I, Hiroshi Torii of 14-5 Tomatsu-cho 1chome, Amagasaki-shi, Hyogo, 661-0003, Japan, do hereby declare that I am the translator of the priority document No.2000-22092 for U.S. Patent Application No. 09/772,994 and certify that the following is a true translation to the best of my knowledge and belief.

Signed this November 18, 2003

Hiroshi Torii

Hiroshi Torii

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This is to certify that the annexed is a true copy of the following application as filed this Office.

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Application Number : 2000-022092

Applicant(s) : Sanyo Electric Co., Ltd.

Date : December 1, 2000

Commissioner, Kozo Oikawa (Sealed)

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[Number of Advance payment ledger]	007320
[Application Fee for Patent]	21,000

[List of the contents]

[Document]	Specification	1
[Document]	Drawings	1
[Document]	Abstract	1

[Assigned Number of Applicant to the Attorneys] 9005894

[Proof] necessary

[Document Name] Specification

[Title of the invention] Solar Cell Module

[Scope of Claim for Patent]

[Claim 1] A solar cell module comprising a plurality of solar cell elements sealed with sealing resin between a front surface glass and a rear surface resin film, wherein a waterproof layer is interposed between the solar cell elements.

[Claim 2] A solar cell module comprising a plurality of solar cell elements sealed with sealing resin between a front surface glass and a rear surface resin film, wherein the waterproof layer is formed so as to cover the interval part between the solar cell elements in the sealing resin.

[Claim 3] A solar cell module comprising a plurality of solar cell elements sealed with sealing resin between a front surface glass and a rear surface resin film, wherein the waterproof layer is provided in a position corresponding to a position between the solar cell elements on an outer side of the rear surface resin film.

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

This invention relates to a solar cell module, particularly a two-side incidence type solar cell module capable of entering light from both front and rear surfaces provided with transparent front and rear surface members.

[0002]

[Prior Art]

Because solar light is unexhausted energy, a solar cell device for directly converting light energy into electrical energy has been developed as energy source to substitute for environmentally harmful fossil fuel such as petroleum and coal. A plurality of solar cell elements are electrically connected in series or in parallel with each other to form a solar cell module and increase their output. The solar cell module can be used as a practical energy source.

[0003]

A conventional solar cell module that generates power on a one side surface, as shown in Fig. 9, is so structured that a plurality of solar cell elements 110 between a front surface glass 100 and a rear surface member 101 are sealed with a transparent and insulative resin 102 such as EVA (ethylene vinyl acetate).

[0004]

The solar cell element 110 contains a single crystalline silicon, polycrystalline silicon or the like, and the solar cell elements 110 are connected in series with connection members 111 of a metal thin plate such as a copper foil plate or the like. The rear surface member 101 is a lamination film with a metal foil such as an aluminum (Al) foil or the like sandwiched with plastic films so that water entrance from a rear surface can be prevented.

[0005]

The above-mentioned solar cell module is integrally formed by sandwiching the solar cell elements 110 between the front surface glass

100 and the rear surface member 101 with a resin sheet of EVA or the like of 0.4-0.8 mm in thickness interposed and heating it at a reduced pressure.

[0006]

A two-side incidence type solar cell element has been proposed, which is so structured that an electrode on a rear surface, not only an electrode on a light incidence side, is a transparent electrode in order to take light into the solar cell elements effectively. In such structure, the rear surface of this solar cell element is formed of transparent materials.

[0007]

[Problems to be resolved by the Invention]

The solar cell modules should be weather proof in order to withstand long-term use outside. The above-mentioned two-side incident type solar cell module uses a rear surface member of transparent materials. The rear surface member made of the transparent materials allows water to enter easier than the rear surface member of the lamination film with a metal foil sandwiched with plastic films does. Further measure to prevent water seeping should be taken. Although the use of a transparent resin film having a low water vapor transmission rate has been proposed, it still requires to be improved.

[0008]

This invention was made to solve above-mentioned conventional problems and to provide a solar cell module with reliability enhanced by improving moisture proofness.

[0009]

[Means of Solving the Problems]

First of all, a solar cell module shown in Fig. 9 including a lamination film of an aluminum (Al) foil sandwiched with PVF (polyvinyl fluoride) films and a solar cell module only including a PVF film were prepared, and a moisture proof test (JIS C8917) on the two modules was conducted to examine causes of degradation of power generation performance by water entrance. In this test, the modules were put in a thermostatic bath of 85℃, 93% RH for approximately 1000 hours and the solar cell characteristics before and after the test are examined. An acceptable value of output is 95% or higher. In this test, the modules were put in the thermostatic bath for 1000 hours. The rate of change in output is 99.0 % when the rear surface member is a lamination film, and the rate is 92.0 % when the PVF film is used. According to a careful consideration of the two solar sell modules, a quantity of sodium in 1g of the resin for sealing the solar cells of the solar cell module using the lamination film is 0.3 μ g/g, and that of the solar cell module using only the PVF film is 3 μ g/g. The quantity of sodium relates to the rate of change in output, and as the quantity of sodium in the resin increases, the power generation performance degrades.

[0010]

It is considered that the quantity of sodium changes under the influence of water entrance. Regarding the solar cell module using the lamination film as a rear surface member, water enters from the outer region of the module. The solar cell module using the resin film as the rear surface member, in addition to the water entrance from the outer region of the

module, receives water through the resin. Thus more water enters the solar cell module using the resin film for the rear surface member.

[0011]

When the water enters the module, the sodium ions deposited from the front glass migrate in the resin containing water to reach the front surface of the solar cell elements, and further diffuse inside the solar cell element to degrade the power generation performance of the solar cell elements. As a result, the power generation performance seems to degrade when the rear surface member is the resin film as compared with the lamination film.

[0012]

This invention was made to improve reliability of the solar cell module by reducing water reaching the front surface glass when the rear surface member is resin film and suppressing the sodium ions deposited from the front surface glass to reach the front surface of the solar cell elements.

[0013]

A solar cell module of the present invention was made in consideration of the above-mentioned problems and comprises a plurality of solar cell elements sealed with sealing resin between a front surface glass and a rear surface resin film. A waterproof layer is interposed between the solar cell elements.

[0014]

With the above structure, water entering though the rear surface resin film is blocked by the waterproof layer and an increase of water contained in the sealing resin between the front surface glass and the

solar cell elements can be prevented.

[0015]

A solar cell module of the present invention comprising a plurality of solar cell elements sealed with sealing resin between the front surface glass and the rear surface member wherein the waterproof layer may be formed so as to cover the interval part between the solar cell elements in the sealing resin.

[0016]

With this structure, water entering through the rear surface resin film is blocked by the solar cell elements and the waterproof layer, and an increase of water contained in the sealing resin between the front surface glass and the solar cell elements can be prevented.

[0017]

A solar cell module of the present invention comprising a plurality of solar cell elements sealed with sealing resin between the front surface glass and the rear surface member wherein the waterproof layer may be provided in a position corresponding to a position between the solar cell elements on an outer side of the rear surface resin film.

[0018]

With the above structure, water entrance is blocked by the waterproof layer and the solar cell elements, and an increase of water contained in the sealing resin between the front surface glass and the solar cell elements can be prevented.

[0019]

[Preferred Embodiment of the Invention]

Explanation is made on the embodiments by referring to the drawings.

[0020]

One example of a solar cell element 1 used in this invention is explained by referring to Fig. 1. Fig. 1 is a schematic perspective view illustrating one example of a solar cell element capable of entering light from both front and rear surfaces. This solar cell element is so structured that intrinsic amorphous silicon is sandwiched between a single crystalline silicon substrate and an amorphous silicon layer (herein after referred as HIT structure) in order to reduce defects on the interface therebetween and improve hetero junction interface characteristics, and is capable of entering light from both front and rear surfaces.

[0021]

As shown in Fig. 1, an intrinsic amorphous silicon layer 11 is formed on an n-type single crystalline silicon substrate 10, and a p-type amorphous silicon layer 12 is formed thereon. A transparent electrode 13 on a light receiving side is formed of ITO on an entire surface of the p-type amorphous silicon layer 12, and a comb-shaped collector 14 of silver (Ag) or the like is formed on the transparent electrode 13 on a light receiving side. A rear surface of the substrate 10 has a BSF (Back Surface Field) structure which introduces an internal electric field on the rear surface of the substrate; a high dope n-type amorphous silicon layer 16 is formed with an intrinsic amorphous silicon layer 15 interposed on a rear surface side of the substrate 10. A transparent electrode 17 on a rear surface side is formed of ITO on an entire surface of the high dope n-type amorphous silicon layer 16, and a comb-shaped collector 18 of silver (Ag) or the like

is formed thereon. The rear surface also has a BSF structure that the intrinsic amorphous silicon layer is sandwiched between the crystalline silicon substrate and a high dope amorphous silicon layer in order to reduce defects on the interface and improve characteristics of the hetero junction interface.

[0022]

A plurality of the solar cell elements 1 of Fig. 1 are connected in series with connection member (not shown), and a solar cell module is formed by sealing the plurality of solar cell elements 1 with EVA (ethylene vinyl acetate) resin between a front surface glass 20 and a rear surface resin film 5.

[0023]

In this embodiment, a transparent resin film of PVF (polyvinyl fluoride) is used as the rear surface resin film 5.

[0024]

In the first embodiment of Figs. 2, 3, the waterproof layer 7 of a metal foil or butyl rubber is interposed between the solar cell elements 1, 1. When a metal foil is used as the waterproof layer 7, insulation process is provided to prevent short-circuit between the solar cell elements 1, 1.

[0025]

An EVA resin sheet 3 of 0.6mm in thickness is interposed between the front surface glass 20 and the solar cell elements 1. An EVA resin sheet 2 of 0.6mm in thickness is interposed between the solar cell elements 1 and the rear surface resin film 5.

[0026]

Each of the layers is superimposed on the front surface glass 20, as shown in Fig. 2, and is held in a vacuumed bath at approximately 100 Pa. Then, this lamination structure is heated to 150℃ and is pressed with a silicone sheet from the rear surface resin film 5 side by using atmospheric pressure. Through these processes, the EVA sheets 2, 3 are softened and are tentatively adhered. Then, it is retained for one hour in a thermostatic bath of approximately 150℃, and the EVA sheets 2, 3 are cross-linked to form the solar cell module shown in Fig. 3.

[0027]

With the structure of Fig. 3, water entering through the rear surface resin film 5 is blocked by the solar cell elements 1 and the waterproof layer 7, and an increase of water in the EVA sheet 3 between the front surface glass 20 and the solar cell elements 1 can be prevented. As a result, sodium ions deposited from the front surface glass 20 are prevented from migrating so as to prevent degradation of power generation performance of the solar cell element.

[0028]

When a metal foil of aluminum is used as the waterproof layer 7 and the reflectivity of a surface of the metal foil increases, light incident between the solar cell elements 1, 1 reflects on the surface of the metal foil, further reflects on a surface of the front surface glass 20 through the EVA sheet 3 again, and enters in the solar cell elements 1, 1. As a result, power generation properties of the solar cell elements 1, 1 are improved.

[0029]

Figs. 4, 5 explain a second embodiment of this invention. The same elements have the same reference numerals as in the first embodiment, and explanation on them is omitted.

[0030]

As shown in Fig. 4, two EVA resin sheets 2, 4 are interposed between the rear surface resin film 5 and the solar cell elements 1. A waterproof layer 8 of a metal foil such as aluminum is interposed between the resin sheets 2 and 4 so as to cover the interval between the solar cell elements 1 and 1. The waterproof layer 8 is larger than the interval between the solar cell elements 1 and 1 so as to cover end parts of the solar cell elements 1 by approximately 2 mm.

[0031]

In the embodiment shown in Fig. 4, an EVA resin sheet 3 of 0.6 mm in thickness is interposed between the front surface glass 20 and the solar cell elements 1, and the EVA sheets 2, 4 of 0.6 mm in thickness are interposed between the solar cell elements 1 and the rear surface resin film 5.

[0032]

As in the case of the first embodiment, each of the layers is superimposed on the front surface glass 20, as shown in Fig. 4, and is held in a vacuumed bath at approximately 100 Pa. Then, this lamination structure is heated to 150 ℃ and is pressed and attached with a silicone sheet from the rear surface resin film 5 side at atmospheric pressure. Through these processes, the EVA sheets 2, 4, 3 are softened and are tentatively adhered. Then, it is retained for approximately one hour in a

thermostatic bath of approximately 150 ℃, and the EVA sheets 2, 4, 3 are cross-linked to form the solar cell module shown in Fig. 5.

[0033]

With the structure shown in Fig. 5, water entering through the rear surface resin film 5 is blocked by the waterproof layer 8 and solar cell elements 1, and an increase of water in the EVA sheet 3 between the front surface glass 20 and the solar cell elements 1 can be prevented. As a result, sodium ions deposited from the front surface glass 20 are prevented from migrating so as to prevent degradation of power generation performance of the solar cell element.

[0034]

Figs. 6, 7 explain a third embodiment of this invention. The same elements have the same reference numerals as in the first and second embodiments, and explanation on them is omitted.

[0035]

As shown in Fig. 6, two EVA resin sheets 3, 4 are interposed between the front surface glass 20 and the solar cell elements 1. The waterproof layer 8 of a metal foil such as aluminum is interposed between the resin sheets 3 and 4 so as to cove the interval between the solar cell elements 1, 1. The waterproof layer 8 is larger than the interval between the solar cell elements 1 and 1 so as to cover end parts of the solar cell elements 1 by approximately 2 mm.

[0036]

In the embodiment shown in Fig. 6, two EVA resin sheets 3, 4 of 0.6 mm in thickness are interposed between the front surface glass 20 and the

solar cell elements 1, and the EVA sheet 2 of 0.6 mm in thickness is interposed between the solar cell elements 1 and the rear surface resin film 5.

[0037]

As in the case of the first and second embodiments, each of the layers is superimposed on the front surface glass 20, as shown in Fig. 6, and is held in a vacuumed bath at approximately 100 Pa. Then, this lamination structure is heated to 150 ℃ and is pressed and attached with a silicone sheet from the rear surface resin film 5 side by using atmospheric pressure. Through these processes, the EVA sheets 2, 4, 3 are softened and are tentatively adhered. Then, it is retained for one hour in a thermostatic bath of approximately 150 ℃, and the EVA sheets 2, 4, 3 are cross-linked to form the solar cell module shown in Fig. 7.

[0038]

With the structure of Fig. 7, the water entering through the rear surface resin film 5 is blocked by the solar cell elements 1 and the waterproof layer 8, and increase of water contained in the EVA sheet 3 between the front surface glass 20 and the solar cell elements 1 can be prevented. As a result, sodium ions deposited on the front surface glass 20 are prevented from migrating so as to prevent degradation of power generation performance of the solar cell elements.

[0039]

A distance between the front surface glass 2 and the solar cell element 1 can be great as compared with the solar cell module shown in Fig. 7; for example the distance can be doubled of one which has the single EVA

sheet of 0.6 mm. As a result, time for the sodium ions deposited from the front surface glass 20 to reach the solar cell elements 1 can be taken longer. Therefore, time taken until starting degradation of power generation performance of the solar cell element can be prolonged and a solar cell module of high reliability capable of withstanding long-term use outside can be provided.

[0040]

Figs. 8 explains the fourth embodiment of this invention. The same elements have the same reference numerals as in the first embodiment, and explanation on them is omitted.

[0041]

Each of the layers is superimposed on the front surface glass 20, as shown in Fig. 8, and is held in a bath at approximately 100 Pa. Then, this lamination structure is heated to 150 ℃ and is pressed and attached with a silicone sheet from the rear surface resin film 5 side by using atmospheric pressure. Through these processes, the EVA sheets 2, 3 are softened and are tentatively adhered. Then, it is retained for one hour in a thermostatic bath of approximately 150 ℃, and the EVA sheets 2, 3 are cross-linked to form the solar cell module.

[0042]

In the fourth embodiment, a waterproof layer 9 of a metal foil or butyl rubber is formed in a position corresponding to an interval between the solar cell elements 1, 1 on an outer side of the rear surface resin film 5 as shown in Fig. 8. When the metal foil of aluminum or the like is used as the waterproof layer 9, it may be attached to the rear surface resin film 5

by using adhesive such as double sides adhesive tape. When moisture proof butyl rubber is used for the waterproof layer 9, the butyl rubber may be pasted to the position for forming the waterproof layer 9.

[0043]

With the structure shown in Fig. 8, the waterproof layer 9 and the solar cell elements 1 block water, and increase of water contained in the EVA sheet 3 between the front surface glass 20 and the solar cell elements 1 can be prevented.

[0044]

The solar cell module of this invention and a comparison sample were subjected to a moisture proof test (JIS C8917). In this test, the samples were put in a thermostatic bath of 85 ℃, humidity of 93 % for approximately 1000 hours and characteristics of the solar cells were examined before and after the test. An output value of 95 % or higher is an acceptable line.

[0045]

Sample No. 1 is one that uses a lamination film, which an aluminum foil, as a rear surface material, is sandwiched by PVF in order to prevent water entrance from a rear surface, and seals the solar cell elements by using an EVA sheet between the front surface glass 20 and the rear surface. Sample No. 2 is one that uses a PVF film as a rear surface material. Sample No. 3 is one that has a structure described in the first embodiment. Sample No.4 is one that has a structure described in the second embodiment. Sample No. 5 is one that has a structure described in the third embodiment. Sample No. 6 is one that has a structure

described in the fourth embodiment. The conditions of each of the samples are the same except for the condition shown in the table and the solar cell elements 1 has the HIT structure of two-side incidence type.

[0046]

The above samples were put in the thermostatic bath of the above conditions and the moisture proof test was conducted. The results are shown in the table 1. The table also shows the results of measurement of an amount of sodium (Na) in 1 g of the sealing resin after a lapse of 1000 hours.

[0047]

[Table 1]

		Rate of change in output characteristic [%]				
		Pmax	Voc	Isc	F.F.	Na quantity /EVA
1	Rear surface resin film of PVF/Al/PVF lamination	99.0	99.8	99.9	99.3	0.3 μg/g
2	Rear surface resin film of PET film (50 μm)	93.5	98.5	99.4	95.5	2.3 μg/g
3	Rear surface resin film of PET film (50 μm), aluminum foil (50 μm) interposed between the solar cell elements	97.5	99.3	99.6	98.6	0.5 μg/g
4	Rear surface resin film of PET film (50 μm), aluminum foil (50 μm) interposed between the solar cell elements and the rear surface resin film to cover the solar cell elements by 2 mm	98.5	99.6	99.8	99.1	0.4 μg/g
5	Rear surface resin film of PET film (50 μm), aluminum foil (50 μm) interposed between the solar cell elements and the front surface glass to cover the solar cell elements by 2 mm	98.4	99.6	99.8	99.0	0.4 μg/g
6	Rear surface resin film of PET film (50 μm), waterproof butyl rubber formed to cover solar cell elements by 2 mm on an outer side of the rear surface resin film	96.8	99.2	99.5	98.1	0.7 μg/g

[0048]

From the table 1, it is found that the performance of the solar cell module of this invention using the transparent resin film as a rear surface resin film and the performance of one using the lamination film as a rear surface resin film are not different greatly. Either of them can satisfy 95 % or higher level of the initial properties, and can achieve the JIS standard.

[0049]

The above embodiments uses the solar cell element of the HIT structure, but other types of solar cell module using other crystalline solar cell elements and amorphous solar cell elements are applicable.

[0050]

[Effects of the Invention]

As described above, this invention can provide a solar cell module of high reliability capable of suppressing deposition of sodium ions from the front surface glass, extending time of degrading power generation performance of the solar cell element, and withstanding long-term use outside.

[Brief Explanation of the Drawings]

[Fig. 1]

Fig. 1 is a schematic perspective view illustrating one example of a solar cell element capable of entering light from both front and rear surfaces;

[Fig. 2]

Fig. 2 is an exploded side view of the solar cell module according to the first embodiment of this invention;

[Fig. 3]

Fig. 3 is a side view of the solar cell module according to the first embodiment of this invention;

[Fig. 4]

Fig. 4 is an exploded side view of the solar cell module according to the second embodiment of this invention;

[Fig. 5]

Fig. 5 is a side view of the solar cell module according to the second embodiment of this invention;

[Fig. 6]

Fig. 6 is an exploded side view of the solar cell module according to the third embodiment of this invention;

[Fig. 7]

Fig. 7 is a side view of the solar cell module according to the third embodiment of this invention;

[Fig. 8]

Fig. 8 is a side view of the solar cell module according to the fourth embodiment of this invention;

[Fig. 9]

Fig. 9 is a side view of the solar cell module according to the conventional solar cell module.

[Explanation of reference number]

1	Solar cell element
2, 3, 4	EVA sheet
5	rear surface resin film
7, 8, 9	waterproof layer

【Document Name】 Drawings

Fig. 1

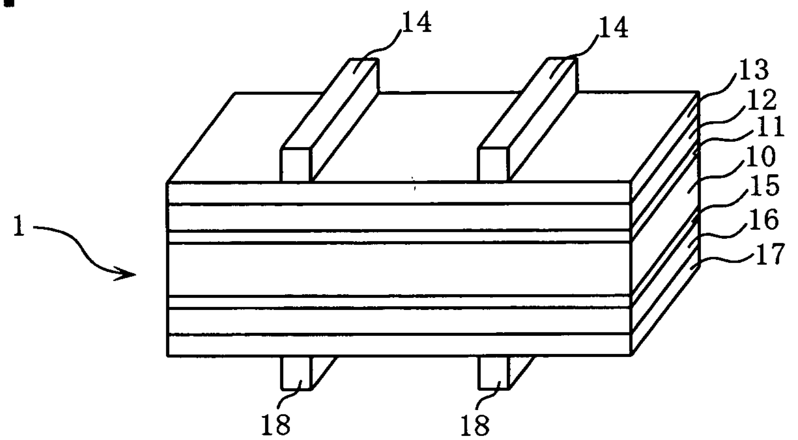


Fig. 2

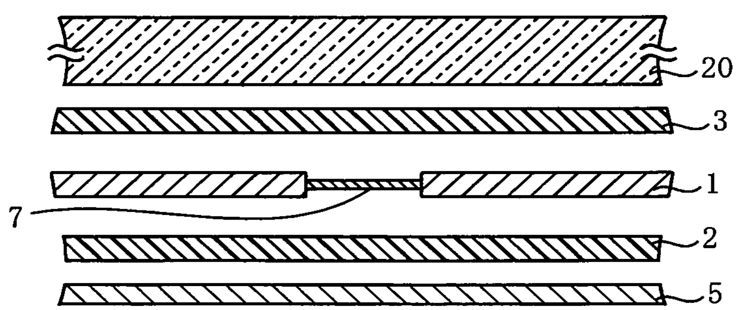


Fig. 3

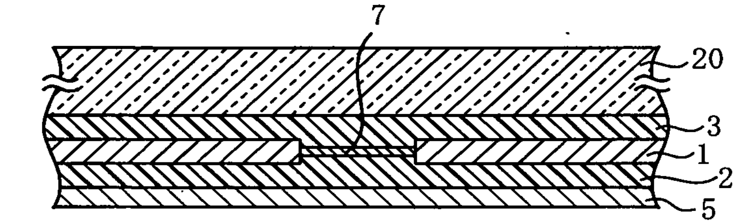


Fig. 4

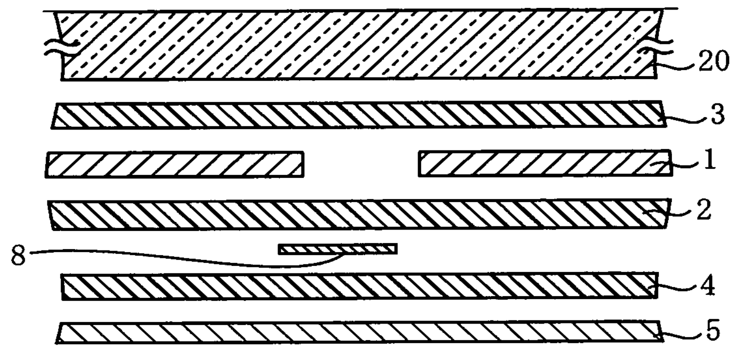


Fig. 5

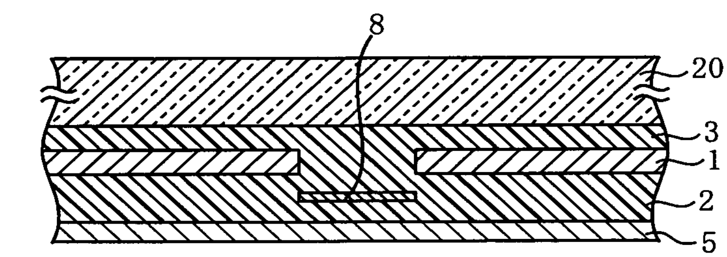


Fig. 6

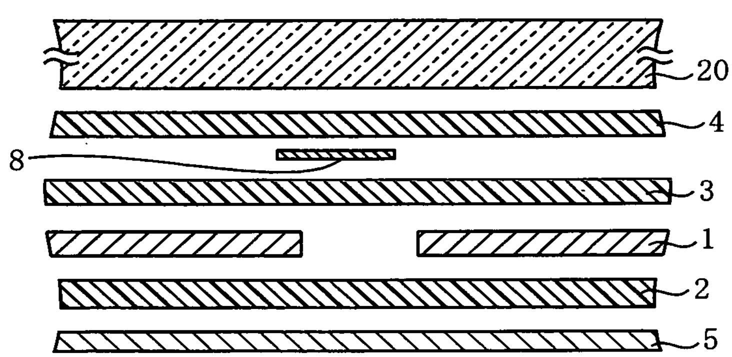


Fig. 7

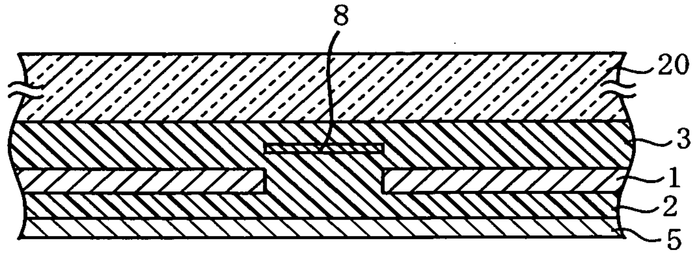


Fig. 8

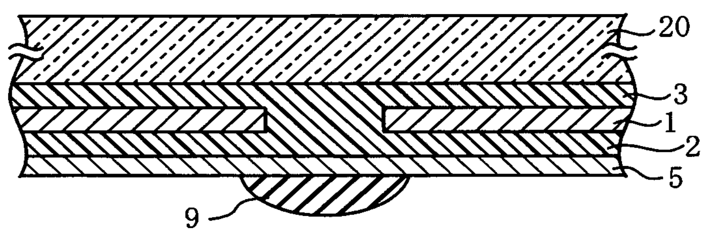
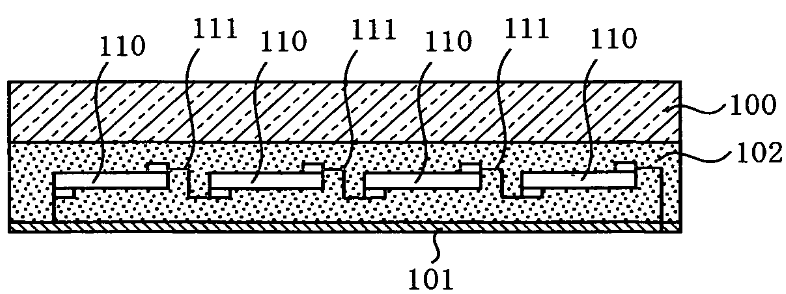


Fig. 9



[Document name] Abstract

[Abstract]

[Object] The present invention has an object to provide a solar cell module with moisture proofness improved by reducing water to reach the front surface glass and suppressing sodium ions to be deposited from a front surface.

[Means to solve]A solar cell module comprises a plurality of solar cell elements 1 sealed with EVA resins 2, 3 between a front surface glass 20 and a rear surface member 5. A waterproof layer 7 is interposed between the solar cell elements.

[Selected drawing] Fig.3